EXPLANATION OF THE CONSTRUCTION AND ACTION OF THE ROBERTS BOILER

PATENTED:

IN UNITED STATES	IN CANADA
October 18, 1887	October 29, 1888
November 19, 1889	December 11, 1893
October 24, 1893	

WORKS:
RED BANK, N. J.
On N. Y. & Long Branch R. R.

MANUFACTURED BY
THE ROBERTS SAFETY WATER TUBE BOILER CO.
39 AND 41 CORTLANDT STREET
NEW YORK CITY

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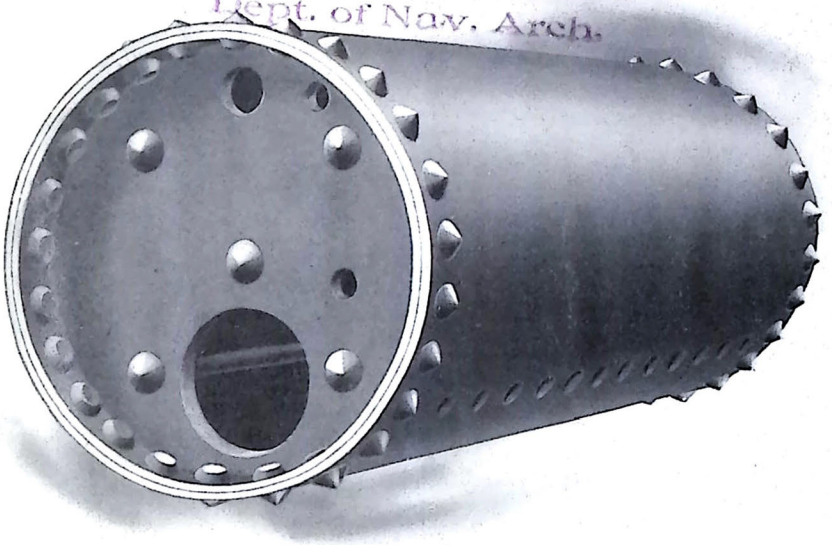

Cut No. 1.

PERSPECTIVE VIEW OF STEAM DRUM.

Cut No. 1 shows a perspective view of the steam drum with the heads riveted in. The shell is made of high grade material, especially for us, in the shape of a lap welded tube in the smaller sizes of boilers, and is approved by the U. S. Steamboat Inspectors in this shape, provided the internal diameter is not over 15 inches. These tubes are never less than three eighths of an inch thick. At present, we use these drums in all sizes of our boilers from No. 1 to No. 9, inclusive. Larger drums are now made of the best quality of marine steel, with the seam

double riveted and holes drilled. All these drums are approved by the U. S. Inspectors for not less than 250 lbs. of steam. The heads of the drum are never less than half inch thick, and are shaped hot, in a "former," which makes them absolutely round and with a perfect flange. These heads are "reversed" and driven in the drum by a powerful ram. The rivet holes are all drilled fair and *not* punched. The heads are then riveted fast and caulked in the most approved manner. You will notice that the heads cannot be driven out of the drum without shearing off every rivet and rupturing the braces. The different cuts are not in proportion to each other, owing to varying distance of camera when photographing. The head does not depend on the strength of its flange, as is usually the case. The cut also shows the row of holes on one side of the bottom of the drum which are tapped (left hand threads) for the connection of the upflow coils. It also shows the large outflow hole in the head into which one of the "Top T's" is screwed, as well as the holes in the head for the connection of one feed coil and for the top connection of the gauge combination. The largest of the small holes immediately at the top of the head is the one through which one of the steam pipes is connected with the spray pipe inside the drum. This spray pipe runs from one head to the other and is drilled full of small holes in its centre on top, so the steam has to rise to the *top* of the drum before entering the spray pipe, thus preventing water from entering with the steam. As the steam is thus drawn from the entire length of the drum there is no tendency for water to rise with it, as might happen if steam was taken from over only one or two points of the water surface. As this photograph was taken from a small drum, it shows only 5 brace heads. Larger drums have more braces. They run from head to head of the drum; are made of the best Ulster iron; are screwed through the heads and then "riveted up" on the outside of the heads. The ends of these braces are swelled to a larger diameter in the fire, so that cutting the threads will not weaken them.

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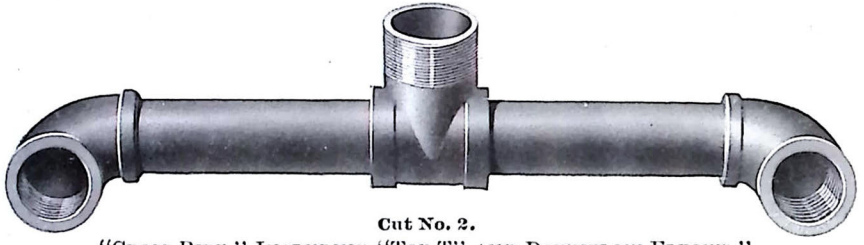
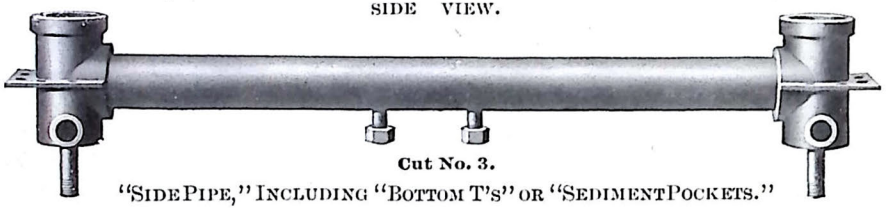
Cut No. 2 shows what we term the cross pipe, including the down flow elbows, and top T, which latter screws into the outlet hole in the head. These fittings are all malleable steel castings and are very soft and tough. The outlet from the head is equivalent in area of cross section to *both* the pipes which branch from it; or



Cut No. 2.
"Cross Pipe," Including "Top T" and Downflow Elbows."

in other words, the top T will pass as much water as the two elbows combined. These threads are all right-hand threads excepting those in the bottoms of the elbows, and the size of the pipes and fittings, of course, depends upon the size of the boiler.

SIDE VIEW.



Cut No. 3.
"Side Pipe," Including "Bottom T's" or "Sediment Pockets."

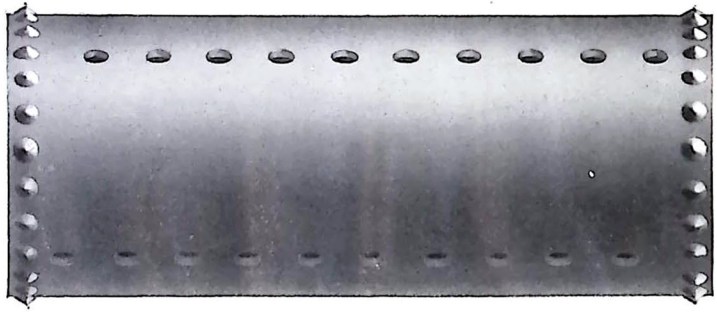
Cut No. 3 shows a side view of *one* of the side-pipes which lies alongside of the fire in the same plane as the grates. Two of the bottom T's or sediment pockets are attached to it, being screwed on with right-hand threads.

Note—The "Top T" and cross pipes are angular on boilers designed for vessels carrying sail.

The flanges extending around the bottom T's are cast on for the purpose of attaching to them the angle iron which runs entirely around the boiler for the purpose of supporting the jacket. You will notice that there is a connection for a blow cock in each one of the sediment pockets. The currents, or circulation in the boiler, carry the sediment to these points. These bottom T's are also made of steel, and have cast to their bottoms bolts which extend into the shipping skids, with nuts on the under side, which are also used for fastening the boiler in the boat. The very large boilers are arranged somewhat differently in regard to these bolts, but the idea is the same. The two bolts near the centre of the side pipe are used for supporting the bearing bars of the grates. They are screwed into the bottom of the side pipe with a taper pipe thread, and they have a bolt thread for the nut, so that it is never necessary to take out the bolt and break the joint, which would make it leak.

Cut No. 4.
SAME AS No. 3—TOP VIEW.

Cut No 4 is a top view of cut No. 3, showing the holes drilled in the side pipe for the bottom connections of the upflow coils. These holes are all tapped *left-handed*, with a standard pipe thread. The side pipes are made of extra heavy pipe so as to get an extra number of threads in the holes.

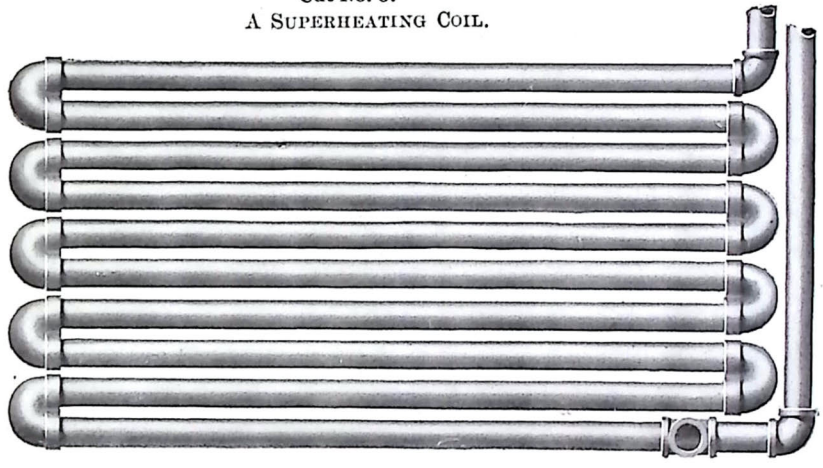


Cut No. 5.

SHOWING HOLES TAPPED IN BOTTOM OF DRUM, TO RECEIVE "UPFLOW COILS."

Cut No. 5 shows the bottom of the drum, with holes tapped alternately on each side. These holes are also tapped left-handed, and receive the top connections of the upflow coils. The two rows of holes are at an angle of ninety degrees to each other, or forty-five degrees each to a centre line drawn along the bottom of the drum.

Cut No. 6.
A Superheating Coil.



Cut No. 6 shows one of the drying or super-heating coils. These coils lie between the boiler and the jacket, or casing, above the fire brick on both sides. They answer the double purpose of drying the steam and of protecting the jacket from the action of the fire. The steam comes from the spray pipe (previously described) into the top of this coil, and after passing through it to the bottom, rises to a point nearly over the end of the drum, where it meets a similar connection from the other superheating coil, and an outlet from both of them is taken to the safety valve, engine, etc. These coils have drain cocks connected to the bottom pipes, for the purpose of draining the coils when the boiler is blown off and laid up in freezing weather. These cocks are shipped with the boiler and must be attached before steam is raised.

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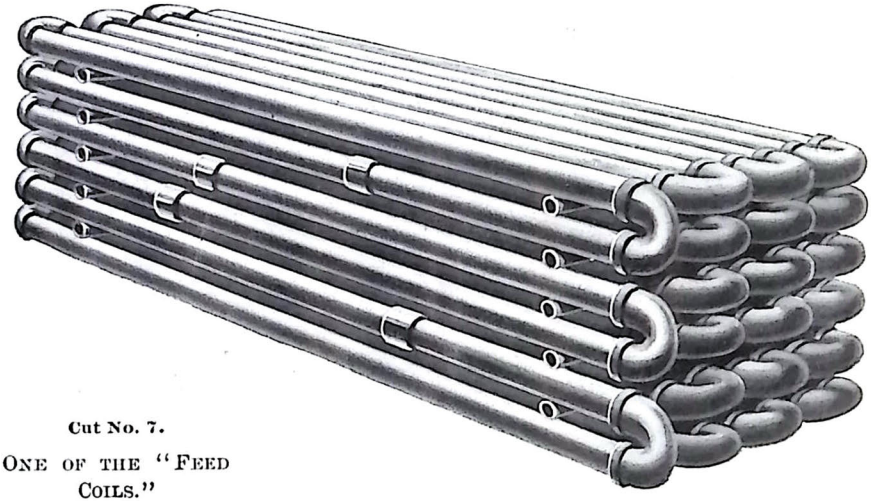

Cut No. 7.

ONE OF THE "FEED COILS."

Cut No. 7 shows *one* of the feed coils. This is complete in itself, and *one* of them lies on each side of the drum above the boiler proper. The feed pipe from the pump or injector passes through the jacket about on a level with the centre of the drum head and enters a T, which divides the feed water into two streams, one of which runs to the *top* of each of these feed coils. The water is passed horizontally through the top layer first, then down to the next one, and horizontally through that, and so continues through each horizontal coil till it reaches the bottom. It is then delivered into the head of the drum above the water line. The reason it is delivered *above* the water line is that it allows any steam, which may have been formed in this coil, to rise to the top of the drum and the water to fall to the water level. With a hot fire these coils sometimes make considerable steam before delivering the water into the boiler proper. You will notice that the water is

continually going *down* through the feed coils and meeting the heat of the fire as it rises.' As the temperature of the gases becomes cooled by contact with the lower feed coils, the gases still rise and come in contact continuously with water that is cooler than they are; thus absorbing very much more heat, and being very much more economical in fuel, than if the action were reversed and the cold water pumped into the bottom of the coil. One of these coils delivers into one head of the drum and the other coil into the other head.* Each coil is connected with the drum with right and left connections shown in another cut, so that they can be easily removed for repairs if necessary. You will notice also on the side of the coil which is facing you in the cut, that each horizontal layer of the coil has a right and left coupling connecting it with the next layer below, so that the whole coil can be easily taken apart to get at any one of its elements. The cross pipes which separate the coils are placed there so the draft will not be obstructed by the coils being too close together. These cross pipes have no water in them, but they last for years, in practice.

*Sometimes both coils deliver into the front head, if a bulkhead in the vessel interferes with getting at the back of the boiler.

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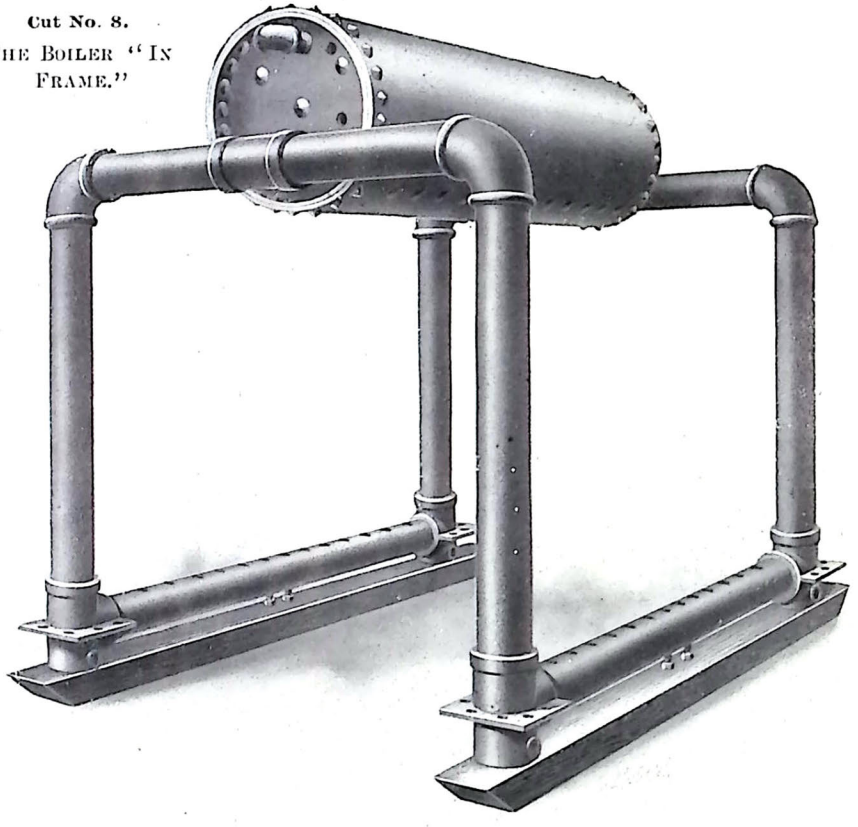
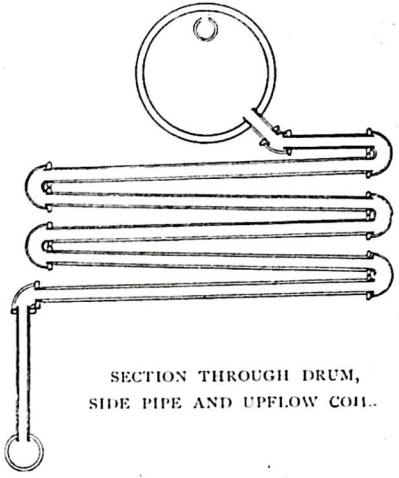
Cut No. 8 shows the boiler "in frame," as we term it. Any mechanic or pipe-fitter can see very easily how it was put together if he will bear in mind that all the screw connections or threads are right hand, except those in the underside of the elbows: thus making the vertical "downflow" pipes what are technically termed "rights and lefts." All outlets, of whatever kind should be taken from the main steam pipe, so as to draw the steam through the superheating coils. There are two reasons for this: one is that it gives dryer steam, and the other that the flow of steam, when the engine is stopped, is continued for feed pump and other auxiliaries through the superheating coils, and has a tendency to prevent the superheaters becoming overheated. When we first commenced to build these boilers we had very serious doubts in regard to the lasting qualities of these superheating coils, as they were the only parts of the boiler which did not contain water; but, much to our surprise, they have run continuously for years, and appear still to be as good as ever.

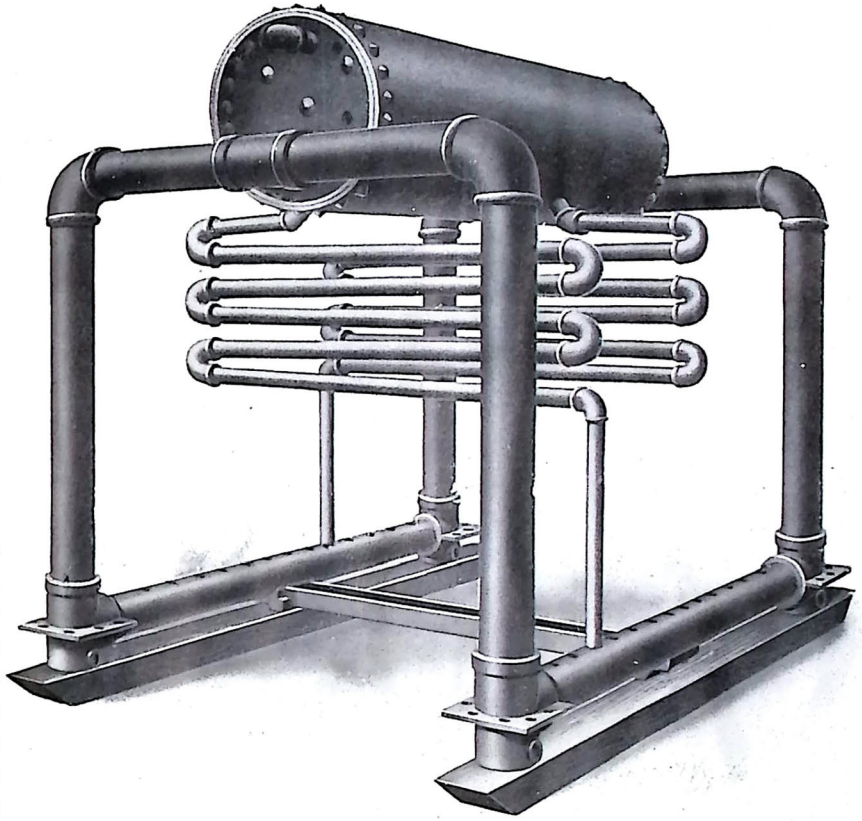


Cut No. 8.
THE BOILER "IN FRAME."

Cut No. 9 shows the boiler with two upflow coils placed in position, and the bearing bars (on which the grate bars rest) also in position. It seemed best to show the boiler with only two of the upflow coils, so as not to confuse the eye, and so you would get a good idea of how they were put in. Remember that the holes in the drum and in the side pipes both have left-hand threads, so that the connections at both ends of the coil are right and left, and therefore any coil can be taken out without disturbing any of the other coils. It is not necessary, as in most boilers, to commence at one end of the boiler and work back to the



SECTION THROUGH DRUM, SIDE PIPE AND UPFLOW COIL.



Cut No. 9.—SAME AS NO. 8, BUT WITH TWO "UPFLOW COILS" IN POSITION.

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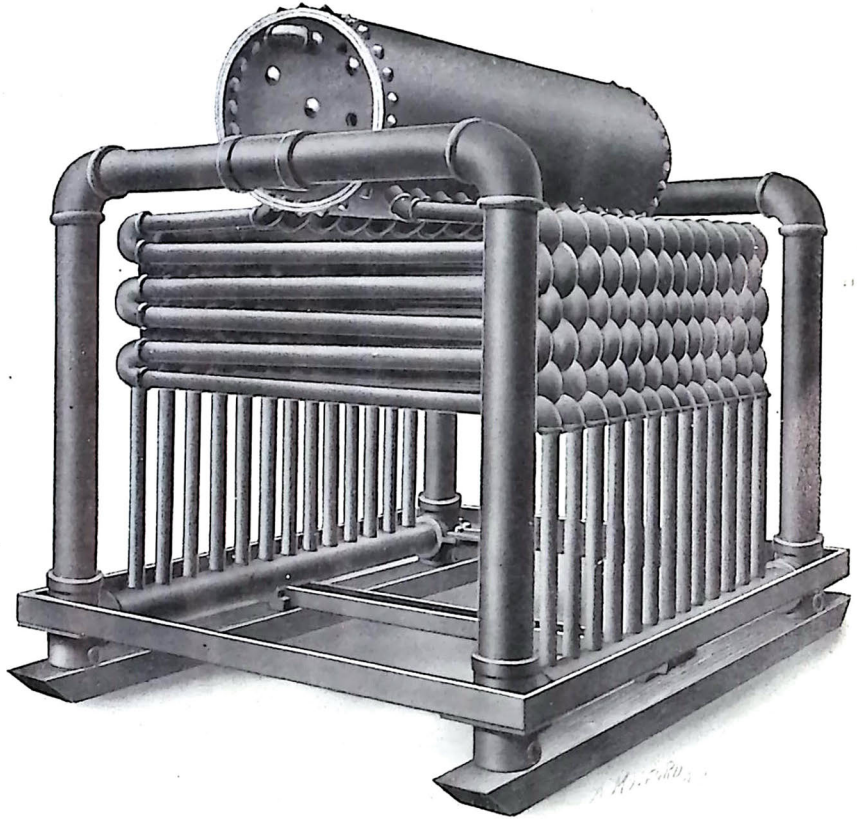
defective coil. Some of our boilers have been in use from ten to twelve years without it having been necessary to remove any coils for repairs, but tubes *in any style of boiler* will wear out in time, and therefore provision has been made for such repairs.

Cut No. 10 shows the same boiler with *all* the upflow coils in position. They are "staggered" — that is, put in alternately from each side — the space between the coils, therefore, being only one-half as great over the fire as is shown at the sides of the furnace. An iron ring around the drum, with a link attached, is furnished with the smaller sizes of boilers and is for the purpose of hoisting the entire boiler in and out of the boat or loading it on cars. This link comes through the smokestack hole in the jacket. The dead plates are also shown in position at each end of the furnace. There is a little shelf, or flange, on the inner edge of each dead



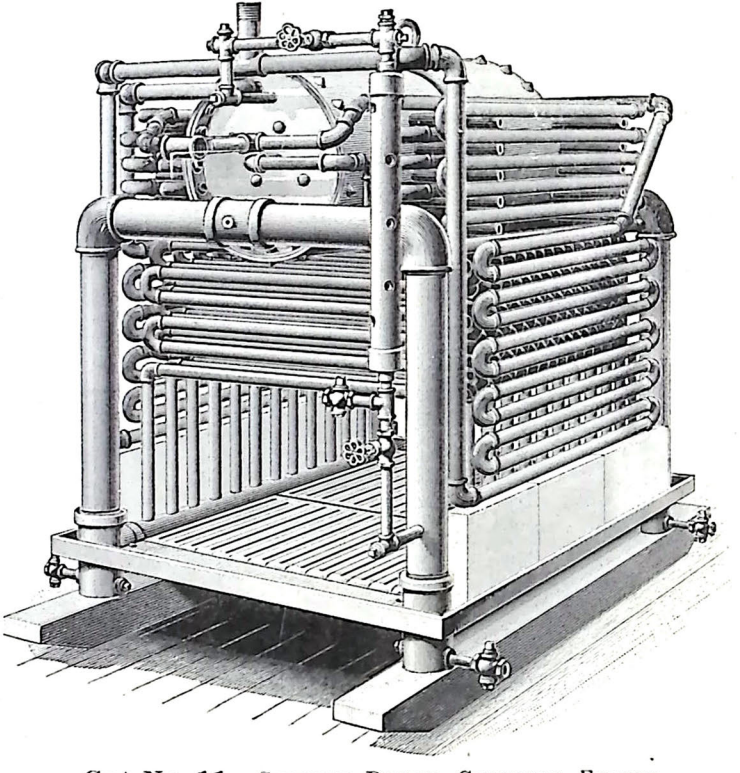
Cut No. 10.—Showing all "Upflow Coils" in Position.

plate. The grate bars rest on these flanges of the dead plates and are hooked over the bearing bars in the centre, but they do not touch each other "end to end," thus leaving an air space between the ends of each set of grates, which permits combustion and allows expansion and contraction of the grates. This arrangement of grates is only made in certain sizes of the boiler, as the very small ones have a single set of grate bars running the full length of the furnace. By special arrangement with the customer, we also insert revolving grate bars, which do away largely with the use of fire tools, and allow the fire to be cleaned without opening the furnace doors. This cut also shows the angle iron running around the boiler for the purpose of receiving the bottom edge of the jacket. These angle irons are in four pieces and are "mitred" in the corners. They are bolted to the flanges cast on the bottom T's. The bottom of this angle iron is filled in with a soft cushion of asbestos, into which the bottom of the jacket cuts with its own weight, making an air-tight joint.

NOTE—Very wide boilers have coils running to the centre of the furnace and back again instead of all the way across, as they would be liable to sag by their weight if extended beyond a certain length.

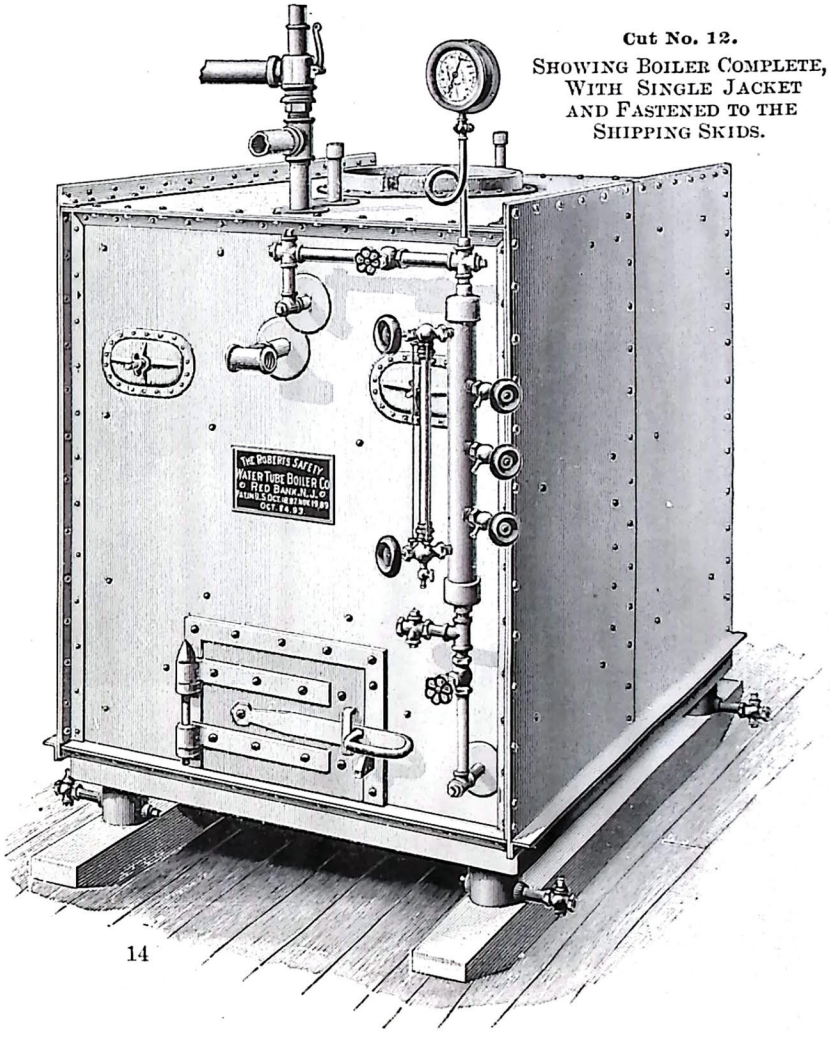
Cut No. 11 shows the boiler complete, with grates in position, and feed coils and superheating coils attached. On the side partly presented to you, you will see an angular pipe leading from the spray pipe at the rear end of the drum and you can trace the course of the steam through the superheating coil to the bottom, whence it rises and escapes through the large T (over the end of the drum) to the engine, safety valve, etc., after uniting with the steam from the superheating coil on the other side. The fire brick shown on the sides are not so thick but what they leave sufficient room for the jacket to enter the angle iron. They are also hollow and porous, being made especially for us, and weighing about one-third as much as ordinary fire brick of equal size. They are also a better non-conductor of heat. The pipe projecting from a point in front of the drum is the one which connects with the T on the outside of the jacket, in cut No. 12. This receives the feed-water and passes

NOTE—We use heavier and more refractory brick in our large steamship boilers.



Cut No. 11.—SHOWING BOILER, COMPLETE, EXCEPT "JACKET" OR "CASING."

it through the corresponding T inside the casing, thus dividing it between the two feed coils, as previously described. The jacket is lined with asbestos and is suitable for an open launch. Steamers having enclosed engine rooms are usually larger than those for which we furnish these small single jacketed boilers, and we then furnish the double jacketed boiler which will be described further on. You will notice that there is a valve near each end of the gauge combination connections, and a cock attached to the outlet of the T just above the lower valve. These are intended for the purpose of "blowing through" all these connections. By shutting the upper valve and opening the lower one, and then opening the cock, you will blow all the sediment out of the lower connection. Then shut the lower one and open the upper one, and the cock, and you will blow through the upper connection. Of course, both of these valves should be open, and the cock



Cut No. 12.
SHOWING BOILER COMPLETE, WITH SINGLE JACKET AND FASTENED TO THE SHIPPING SKIDS.

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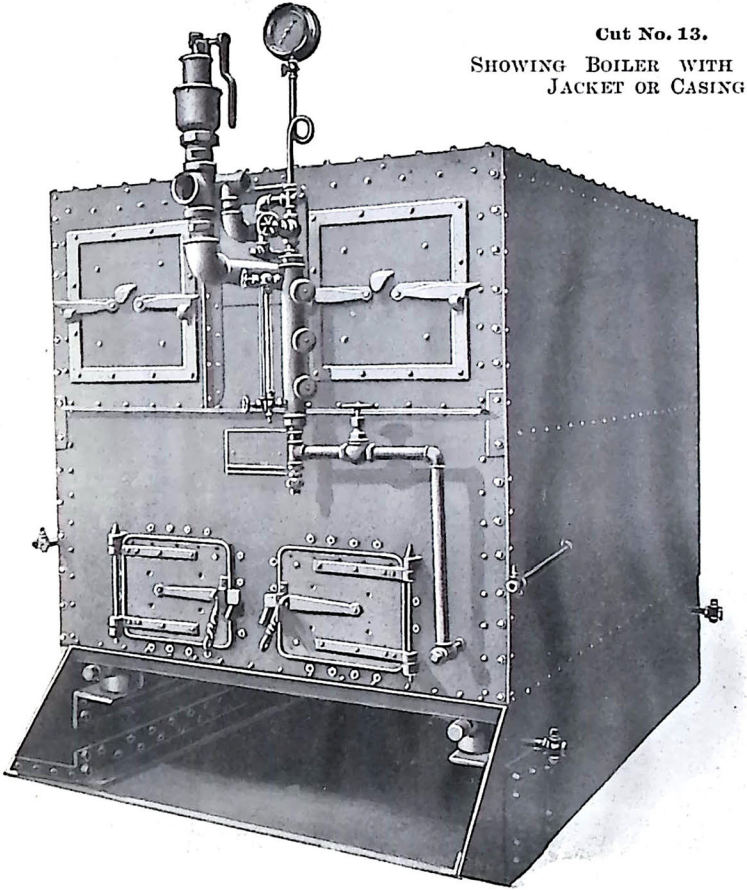
closed, except when blowing through. The bottom connection is made with a T, instead of an elbow, and there is a plug in it, for drainage in the Winter time, or for passing a light rod for clearing, in case it is stopped up from neglect. The top and bottom connections of the gauge combination are right and left so that it can be easily disconnected and taken off and, by disconnecting the rest of the pipes, the jacket can be lifted from its asbestos cushion like the hat from your head. You can then get at any part of the boiler without any difficulty whatever. Any section of the jacket can be removed separately, however. We strongly advise the purchaser to have a removable hatch in the deck over the boiler, so as to allow this jacket to be lifted off for inspection or repairs of the boiler. There is also a growing tendency among local inspectors to require this on annual inspections, when the boiler has been used for several years. This tendency is not confined to this type of boiler.

Cut No. 13 represents a double jacketed boiler. Every section of the jacket is double and filled in with magnesia, or asbestos, 1½ inches thick. You will notice two vertical rows of tap bolts, one near each edge of the front. These bolts are tapped into the ends of the side sections; the back section is fastened in same way. By taking out these bolts the front and back will come off, and the sides will fall apart, the top of course, having been previously lifted out.

Suitable changes in construction are made for boilers to be used exclusively with soft coal or wood as fuel.

You can remove the caps from the two nipples which project from the sediment pockets near the top of the ash pan. You will then be able to run a cleaning tool through the side pipes or distributors.



Cut No. 13.

SHOWING BOILER WITH DOUBLE JACKET OR CASING.

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GENERAL NOTES.

The downflow pipes and side pipes in these boilers are about equal in area of cross section to that of all the upflow coils. That is, they will pass at least an equal amount of water, so that the upflow coils are constantly kept full.

In these boilers the steam in the spray pipe starts from the centre and flows to both ends, constantly receiving accessions of more steam through the holes in the spray pipe. The water also runs from the centre of the drum to both ends, increasing in velocity as it receives more water from the upflow coils between the centre and the heads. The water then flows out through the heads of the drum and down through the "downflow" pipes, throwing its sediment into the sediment pockets, and then travels from the ends to the centres of the side pipes, where the two currents meet.

In boilers of considerable width, instead of running the coils entirely across the boiler, we run them only to the centre. In this case the coils are not "staggered," but the opposite coils meet each other in the centre of the boiler.

We have patented the boiler in every possible shape in which the principle involved can be used practically, including using "downflow" pipes standing at an angle instead of vertically. We are further protected by the fact that the boiler is only approved by the United States Inspectors as the "Roberts" Boiler, and, consequently, cannot be used without our name plate. Even should a pirated boiler be passed, through the ignorance of an inspector in regard to the law, it would become a matter of record on the books of the department, and it would, consequently, be very easy for us to ascertain from said books the name of any vessel using one of our boilers.

These boilers are all tested at our works at 500 pounds per square inch hydrostatic pressure, and they are passed by the United States Inspectors for 250 pounds of steam and upwards.

Boilers of size No. 1 to No. 10, inclusive, are usually built with single sectional jackets, lined with asbestos, and are complete with single smokestack, ash pan, grates, pop marine safety valve, 400 pound steam gauge, gauge syphon, three gauge cocks, glass water gauge, four blow-cocks, furnace door, shipping skids and asbestos packing for smokestack stuffing box; also gauge combination, complete with blow through valves, as shown in cut. Boilers larger than these sizes are generally made with the double sectional jackets and are charged for by

the square foot of grate surface. All the above fixtures are included with the larger boilers except the smoke-stack and ash pan, which latter it is as necessary, usually, to fit to the boat as to the boiler, and could only be made, in the majority of cases, to drawings furnished by the purchaser or his engineer. That is, if anything very elaborate is required.

One peculiarity about these boilers is, that they can be made to fit the space in the boat to an inch, and can be wider than their length if preferred. It is evident, where a cylindrical vertical boiler has been used, that our boiler will have more grate surface and heating surface in the same space, owing to its rectangular shape, which fills up the corners previously not occupied and which were valueless. When the boiler is wide enough to have two furnace doors it can be set much closer to the engine, as, in firing, the fire tools can be used on each side of the engine instead of directly in front of it. We sometimes make these boilers in a manner that we term "reversed," in which case the fire doors are forward in the boat and the back of the boiler is set close to the engine, with the steam outlet and all gauges attached at that end. There is no extra charge for "reversing."

In case revolving grate bars are desired we can furnish them for an extra charge. The advantage of using them is, that in steady running no fire tool is necessary except the shovel, and, consequently, the fire-room can be shortened up, thus giving more space in the boat. Of course, in banking fires a hoe would have to be used, but it is not supposed that the fires will be banked while the engines are running. The revolving bars do not interfere with banking. It is not desirable to open the furnace doors, as a rush of cold air into them has a tendency to retard the production of steam. The revolving bars can be shaken or turned over one at a time, and the ashes are thus detached from the under side of the fire and the clinkers ground up and deposited in the ash pan, thus keeping a fresh, bright fire constantly. Any one of the bars can be grasped and drawn out to allow the fire to drop into the ash pan in case of accident; also, as both ends of the bar are free, it is at liberty to expand. It is not suitable for pea coal as the air spaces would be too small in proportion to the necessary thickness of the bar.

Action of the Boiler.

The boiler, being filled with water until the drum is about one-quarter full vertically, and the fire started, the water is rarified in the "upflow" coils much faster than in the "downflow" pipes, on account both of its

greater sub-division in the small pipes, and also on account of the small pipes being in a position where they absorb a much greater amount of heat. The result is that the water at once commences to rise in the small "upflow" pipes, and to fall in the large "downflow" pipes. As soon as steam bubbles commence to form, this movement of the water is greatly accelerated, as water containing these bubbles is *very much* lighter, bulk for bulk, than solid water, even if their temperature be the same. The upflow coils now begin to throw fountains of water, mixed with steam bubbles, into the drum. The steam bubbles break, the steam escapes to the spray pipe, and their watery envelopes, and other solid water, flow out of each end of the drum (through a hole in the lower part of the head) into the connection to the downflow pipes. At the foot of each of these downflow pipes is a mud-pocket, into which all sediment is "fired" by its own momentum, to be discharged by a blow-cock attached to each pocket. Just above these pockets the downward currents make a turn at a right angle into the side pipes, the upflow coils picking the water up again as it passes under them. The current in each side pipe runs from the ends to the center, and there forms an eddy, the only still water in the boiler (excepting the mud-pockets). Water containing much lime should be entirely blown out whenever it becomes "saturated," or the lime will form scale.

Steam flows from the centre to the ends of the drum through the spray pipe.

Water, at the surface, flows from the centre of the drum to its ends.

Water in the "side pipes" or "distributors" flows from their ends towards their centres.

The boiler is divided practically as follows:

1st. The "down flow" system, including the steam drum and the "side pipes" or "distributors."

2nd. The "upflow" or "generating" system—which includes all pipes, or tubes, between the grates and the bottom of the steam drum.

3rd. The "feed water heating coils," or "economizers," which lie on each side of the drum and absorb the heat which has not been previously absorbed by the generating system.

4th. The steam superheating system, which contains steam only, and lies between the boiler proper and the sides of the casing — on *both* sides of the boiler. This is really part of the main steam pipe — connecting the latter with the spray pipe inside the steam drum, and absorbing heat during the flow of the steam through same.

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